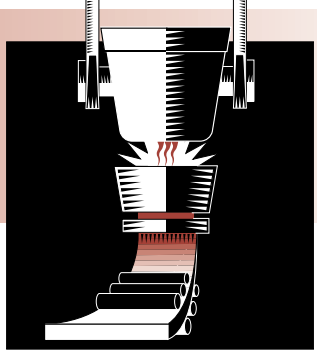
STEEL

Project Fact Sheet



Intelligent Inductive Processing

Benefits

- Energy savings of up to one quadrillion British thermal units (Btu) by the year 2015 if half the steel parts currently carburized can be converted to induction hardening
- 20% increase in strength-to-weight ratio over existing applications
- Maintain the competitive position of case hardened steel components with respect to alternative materials in high strength-to-weight ratio applications
- Decreased product and process development lead times

Applications

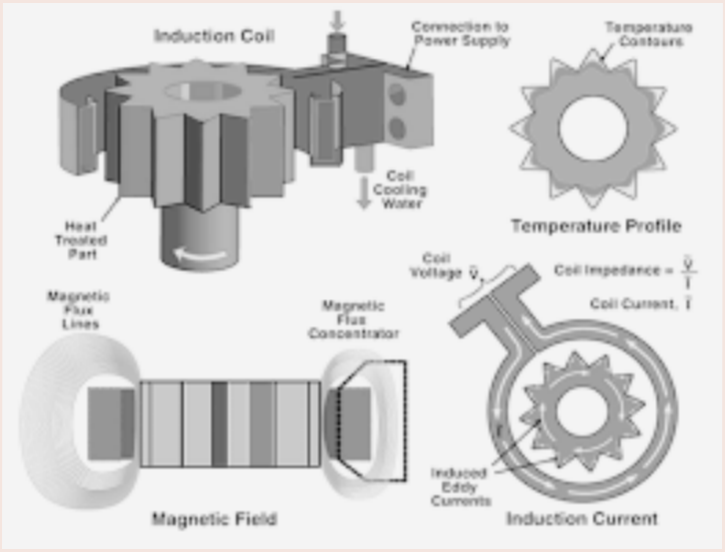
Successful completion of this project will provide common materials specification metrics for induction heat treating, which will allow simplification of the steel mill product mix, and will enable significantly broader use of inductive processing for hardening and process heating, and allow the tailoring of properties of bar stock, strip and tubing at the steel mill.

Improvements in induction heating technology can increase yields and improve quality

Intelligent, model-based design and control of induction heating and hardening enables dramatically decreased product and process development cycle times, improved product quality, decreased product cost, and maintains the competitive position of steel in applications requiring high strength-to-weight ratio at an affordable cost.

Induction hardening is widely used to provide enhanced strength, toughness and wear resistance in components made from wrought steels, and cast irons. The process is energy efficient and environmentally benign, requiring no hazardous gases and no plating or stripping tanks. However, closed-loop control and optimization of the process has eluded industry for over five decades due to inadequate understanding of material/process interaction, process fundamentals, and the lack of appropriate process sensors. Open-loop process control requires periodic sectioning of parts to inspect for compliance with specifications, and an expensive, iterative, cut and try approach for product and process development.

Induction Heating Process



Schematic of the induction heating process.

Improvements in Induction Heating Technology (Continued)

Even so, hundreds of millions of dollars worth of steel parts are induction heat treated annually in the automotive, consumer products, oil field, industrial, transportation, mining, and aerospace industries. Maintaining the competitive position of steels for many of these applications requires steel-based technologies that decrease product and process development time, decrease the waste and inefficiency of periodically sectioning parts, dramatically reduce the amount of energy used to surface harden components, and increase the strength-to-weight ratios of parts, all of which combine to decrease system and component cost. Further development of intelligent inductive processing will broaden the market for hardenable wrought and cast steels and simplify the steel mill product mix by providing common materials specification metrics for components to be induction-hardened. Manufacturing reliability and agility will be improved. This project also enables broader use and tighter control of induction heating in steel mills, and will allow the mills to tailor the properties of bar, strip, and tubing prior to shipment to their customers.

Project Description

Goal: There are three primary objectives of this project: 1) to develop a rigorous multi-physics computational model of the process that provides process simulation capability; 2) to develop, and deploy robust science-based sensors and closed-loop controllers applicable to a broad range of steels, processes and component geometries found in industrial environments; and 3) to use these tools to develop steel components with optimized strength-to-weight ratios.

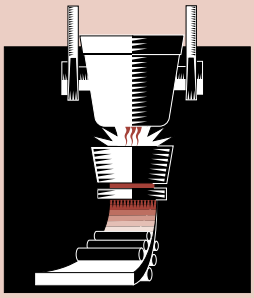
This project will enable broader use of induction heating for process heat in steel mills, and allow the tailoring of properties of bar stock, strip, and tubing. The technologies developed will also be relevant to induction heating in the forging, casting, special metals, and textile industries, as well as enable impulse drying in the pulp and paper industry.

Progress and Milestones

- Project start date, November 1996.
- A previous Cooperative and Development Agreement (CRADA) developed an intelligent closed-loop controller that is operating on the factory floor at Delphi Saginaw for one material and component geometry. This project will broaden the applicability of this technology.
- A CRADA between Sandia National Laboratory and the industrial partners was signed in November, 1996 to investigate the induction hardening process.
- A three-dimensional simulation capability has been developed, coupling all required code modules to predict the microstructure, hardness, and residual stress distribution for plain carbon steels. This simulation capability is currently being validated.
- Localized electromagnetic sensors have been developed that monitor induction heating. Incorporation of these sensors into single shot and scanning controllers is being evaluated.
- Project completion date, December 2000.

Commercialization Plans

This project is a four-year CRADA between Sandia National Laboratory and the industrial partners. Each of the participating companies will be evaluating the intelligent induction-hardening technology for implementation on the plant floor and for use in advanced product design. Already, Delphi Saginaw Steering Systems has produced intermediate axial shafts for General Motors Saturn vehicles that are case-hardened using the new process controller. In addition, Ford Motor Comany has installed and evaluated a similar controller for induction-hardening process control in their manuacturing facilities. A controls systems integrator is being sought to commercialize the advanced sensor and control technology as part of the project. Likewise, a software support entity is sought to commercialize the computational simulation software.



Project Partners

American Iron and Steel Institute
Automotive Applications
Southfield, MI

Chrysler Corporation
Auburn Hills, MI

Delphi Saginaw Steering Systems
Saginaw, MI

Ford Motor Company
Dearborn, MI

Sandia National Laboratory
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